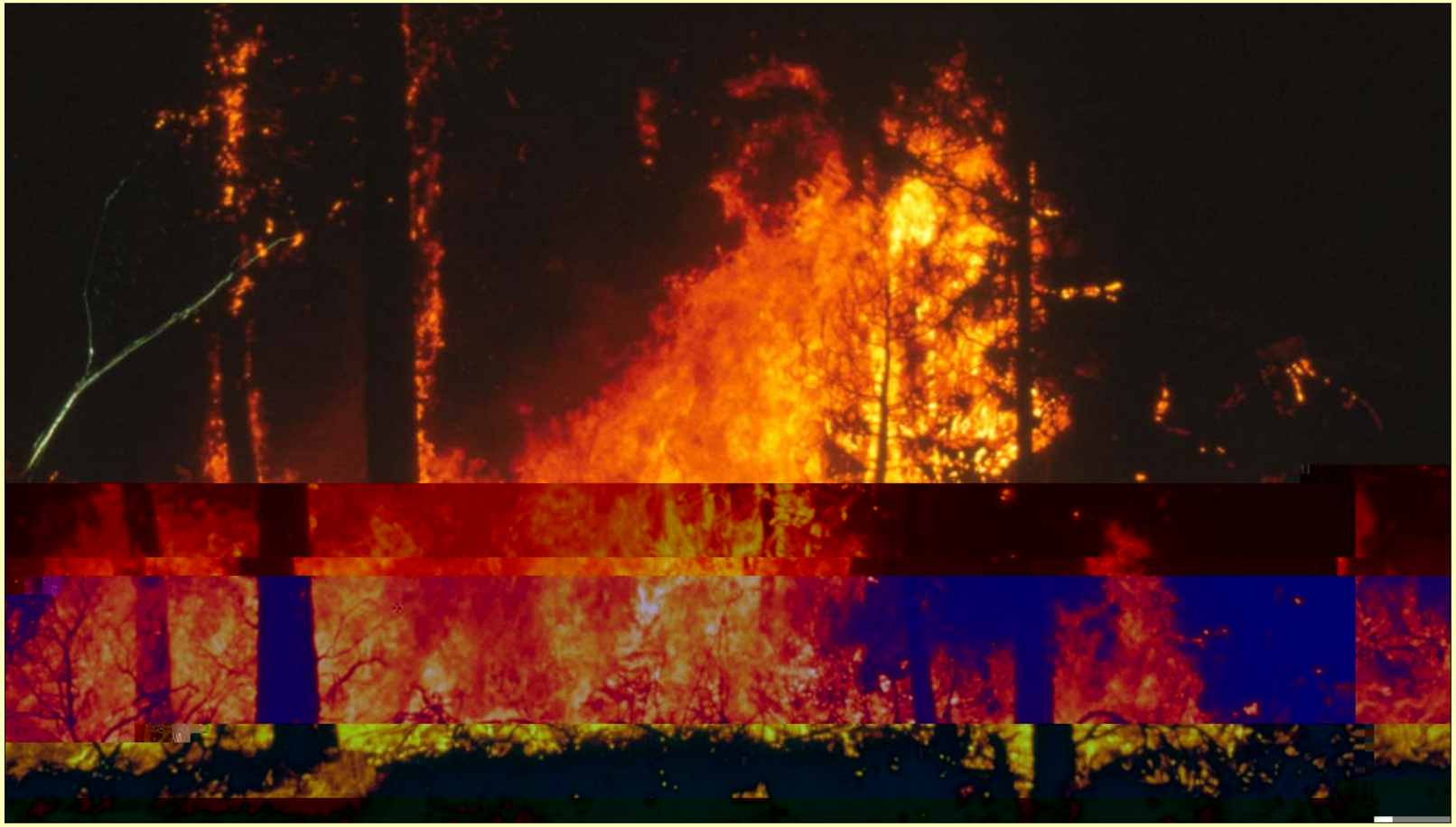
Implications of mixed severity fire ecology for dry forest management



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1 Motivation

Fire severity measures the effects of wildfire intensity on the vitality of biota. Despite awareness of interrelations between patterns of fire severity and landscape conditions, little research has been done to characterize spatio-temporal patterns and variation in historical fire severity. The objectives of this retrospective study were:

1) To determine the most likely severity of the last pre-management era fire on patches within subwatersheds of eastern WA

2) To quantify the relative abundance of low, mixed, and high severity fires among dry and moist mixed conifer potential vegetation types

2 Motivation

Based on the fire severity definitions of Agee (1990, 1993).

HSF≥70% of the total canopy cover or basal area is destroyed by fire

20<MSF<70% of total canopy cover or basal area is destroyed by fire

LSF≤20% of the total canopy cover or basal area destroyed by fire

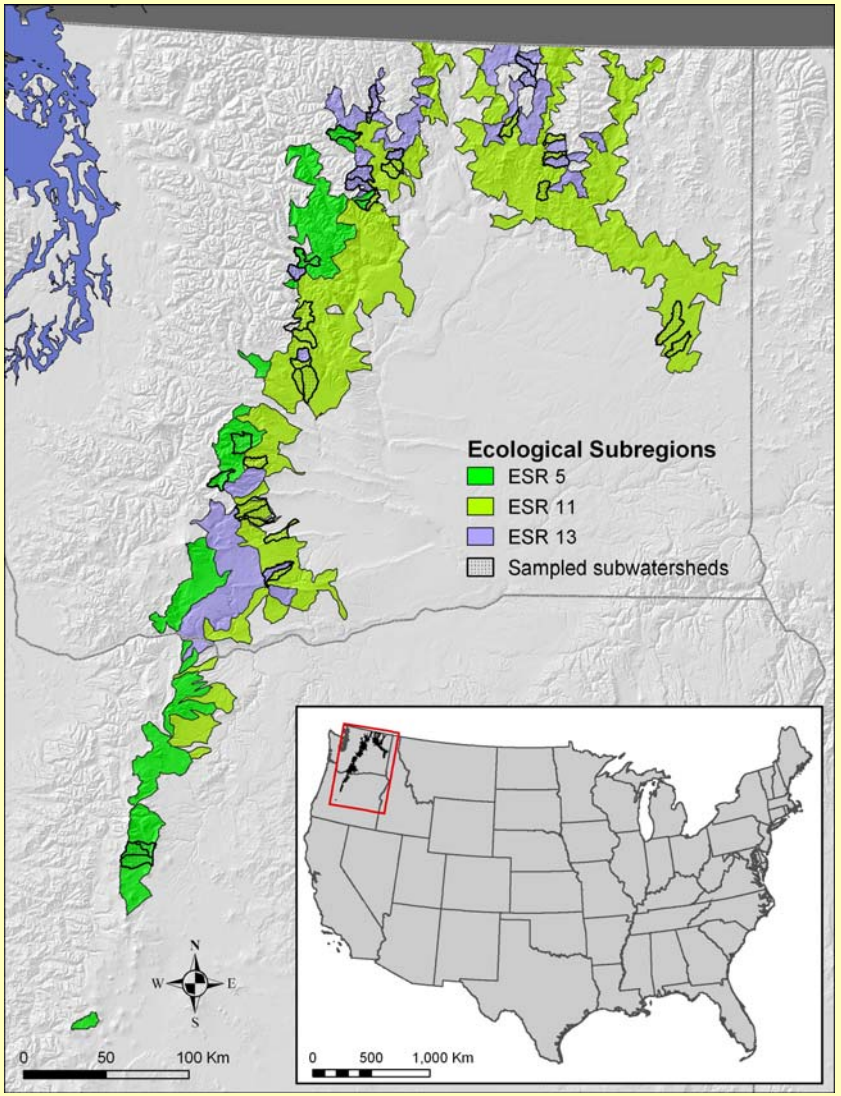
3 Study Area

The study area was selected from three Ecological Subregions (ESR) of the Interior Columbia Basin (Hessburg *et al.* (2000).

ESR5: Composed primarily of moist mixed conifer and cold forest types with dry forests in the lower elevations

ESR11: Composed of extensive dry and moist mixed conifer forests above grasslands and shrublands

ESR13: Composed of moist and dry mixed conifer and other cool/wet forest types in the higher elevations



Subwatersheds range in size from 4,000 to 20,000 ha representing a 10% sample of subwatersheds and area of each Subregion. For reference, a subwatershed represents the 6th level in the established USGS watershed hierarchy.

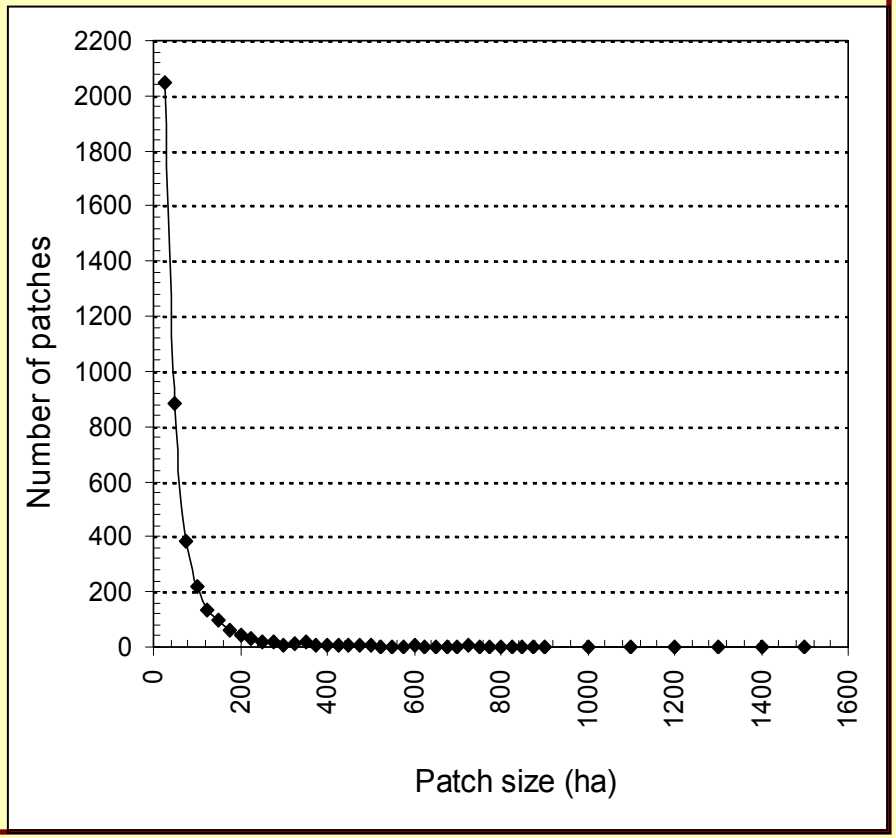
4 Methods

Photo-interpretation of vegetation attributes

The oldest available stereo aerial photos for each study subwatershed (1930's to 40's) were stereo photo-interpreted to determine vegetation attributes (canopy cover, species composition, and size class of the overstory and understory). A new patch was delineated with any single class difference between adjacent patches.

A minimum patch size of 4 ha was adopted based on the results of preliminary investigations.

- 303,000 ha photo-interpreted
- 5,741 total patches
- Patch sizes range, (4 to 3,373 ha)
- Patch size distribution, neg. exp.
- 88% of patches<100 ha

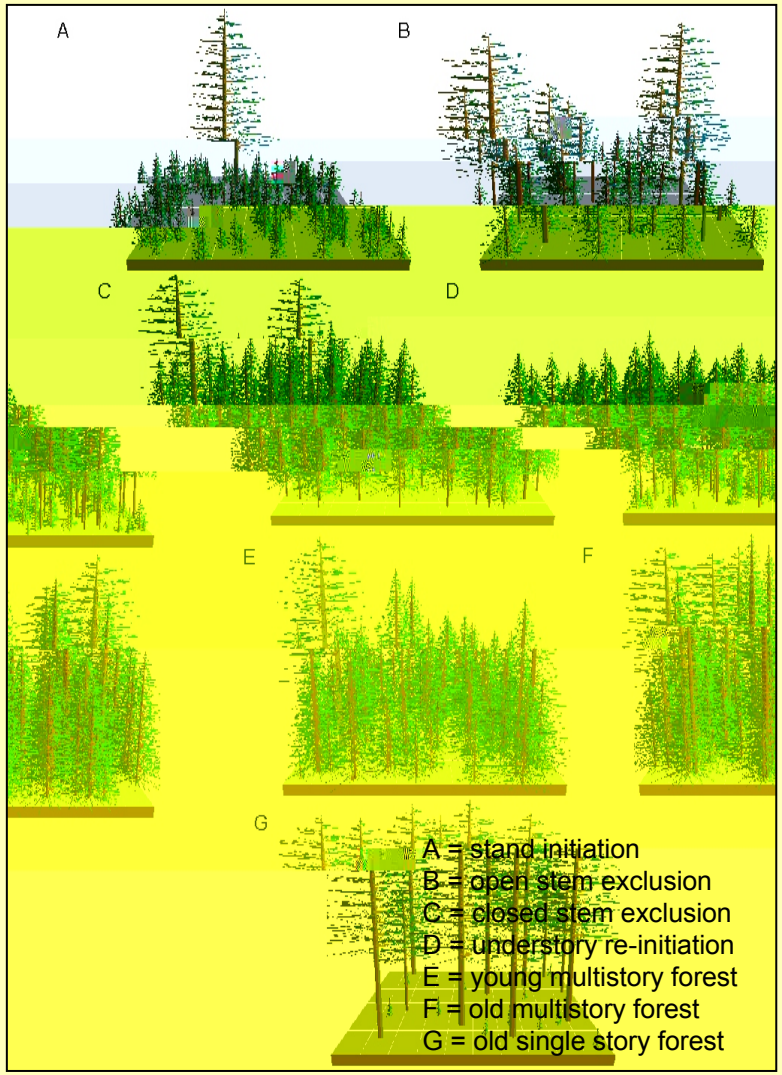


5 Methods

Deriving additional vegetation attributes

Using the photo-interpreted vegetation attributes, several additional attributes were derived for every patch.

- ***Structural class:*** Classes represent key mileposts in stand development, where they partition a continuum of conditions resulting from interactions among stand dynamics, succession, and disturbance processes (*sensu* O'Hara et al. 1996).
- ***Cover type:*** Adopted from the Society of American Foresters "cover type" definitions used to represent actual vegetation cover (*sensu* Eyre 1980).
- ***Potential vegetation type:*** Theoretical endpoint of succession in the absence of disturbance; it identifies a unique biophysical setting that supports a distinctive plant community (*sensu* Keane et al. 1996).

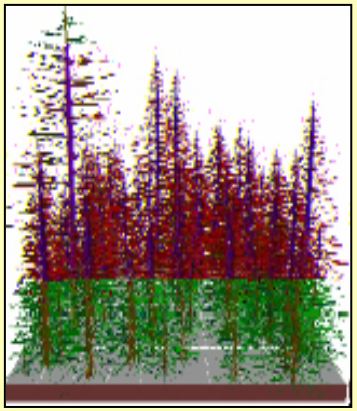


6 Methods

Reconstructing pre-harvest vegetation

The effects of early timber harvest were eliminated by reconstructing the vegetation attributes of every patch showing evidence of harvesting using Moeur and Stage's (1995) most similar neighbor (MSN) imputation method, which maintains multivariate relations between a set of global variables & the local variables.

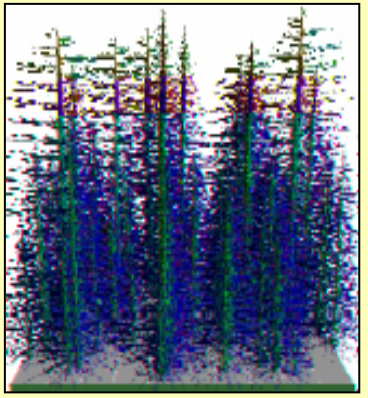
- For the study area, 14.5% of the area showed evidence of logging entry with 75% of that area being light selection cutting.
- All statistical analyses were run with and without the vegetation reconstruction to evaluate the effects of the reconstruction. Result: No statistically significant differences were detected.



Young multistory forest

Patch showing evidence of logging entry

Old multistory forest



Stand-in patch selected by MSN

7 Methods

Classifying fire severity

Fire severity was classified from the photo-interpreted attributes--overstory canopy percent (ratio of overstory to understory canopy cover), overstory and understory size class, and the derived attribute cover type. Overstory canopy percent is consistent with the fire severity definitions of Agee (1990, 1993).

A dichotomized key to fire severity classification

1a. Patch is not forested

2a. Patch is rangeland .....High Severity

2b. Patch is non-rangeland .....No Severity

1b. Patch is forested

3a. Overstory size class ≥ small trees and understory size class ≤ small trees

4a. Overstory canopy percent ≥ 80%

5a. Cover type is not fire tolerant .....High Severity

5b. Cover type is fire tolerant .....Low Severity

4b. Overstory canopy percent < 80%

6a. Overstory canopy percent ≤ 30% .....High Severity

6b. Overstory canopy percent > 30% .....Mixed Severity

3b. Overstory size class < small trees or understory size class > small trees

7a. Overstory size class < small trees .....High Severity

7b. Understory size class > small trees

8a. Overstory canopy percent ≤ 30% .....High Severity

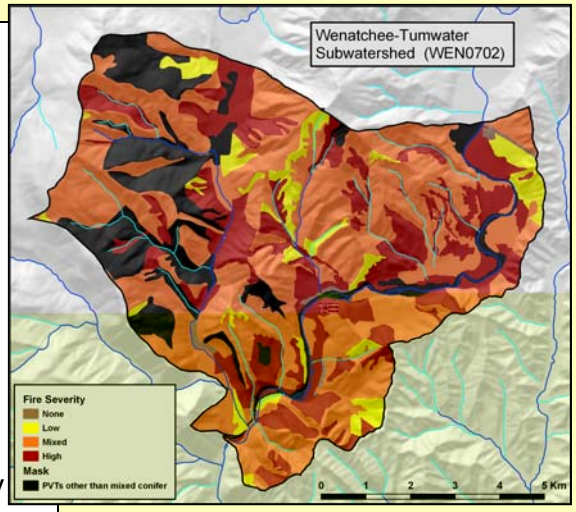
8b. Overstory canopy percent > 30%

9a. Overstory canopy percent ≥ 80%

10a. Cover type is not fire tolerant.....High Severity

10b. Cover type is fire tolerant .....Low Severity

9b. Overstory canopy percent < 80% .....Mixed Severity



Small trees are 22.7-40.4 cm at dbh

Fire tolerant cover types are: PP, WL, DF

Fire intolerant cover types are: LPP, GF, PSF, SAF, ES, WH, WRC, MH, WBP, SAL, hardwoods.

8 Results

Statistical analysis

- We applied non-parametric rank ordered tests based on the Chi-square distribution to test for significant differences ($P \leq 0.05$) in area of a fire severity class by cover type, potential vegetation type, Subregion, and study area.

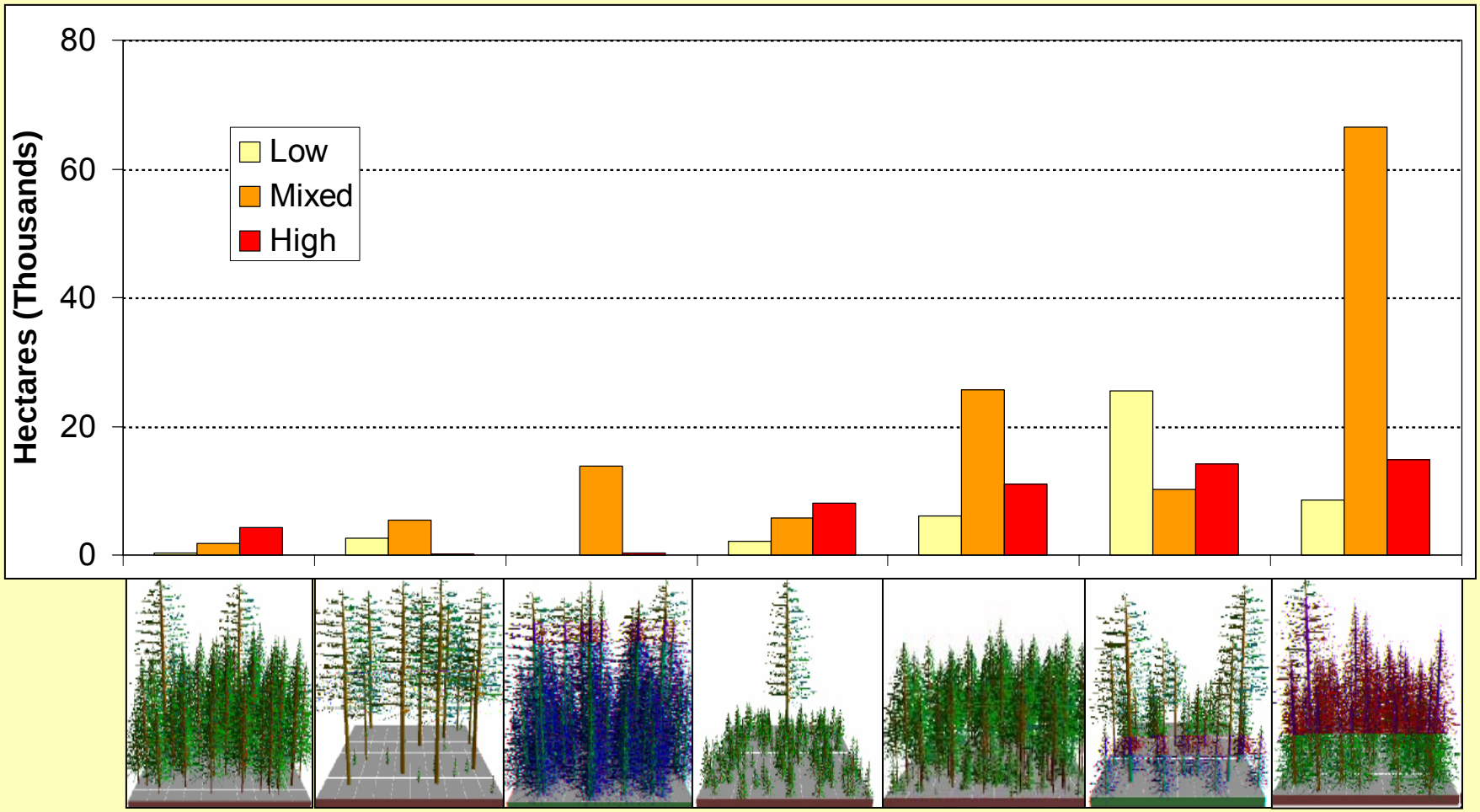
- We used the Kruskal-Wallis H-test to compare observed and expected area in fire severity classes of ponderosa pine (PP) or Douglas-fir (DF) cover types in dry or moist forest, within and among Subregions, and for the study area.

- Significant difference was evaluated using the Mann-Whitney U pairwise post-hoc comparison procedure.

- The Mann-Whitney U-test was also used to compare area in fire severity classes of PP and DF cover types, and area within severity classes by potential vegetation type within Subregions, and for the study area.

10 Results

Fire severity by forest structural class (from a different angle)

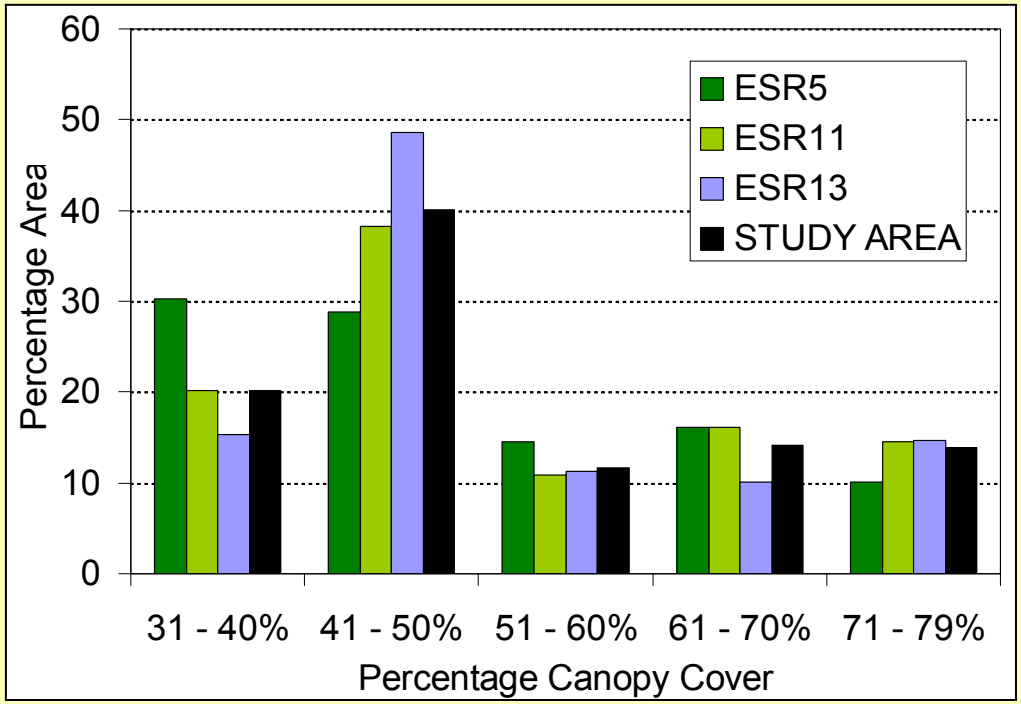


11 Results

Variability of mixed severity fire in the dry forests

- Across the study area, 40% of the dry mixed conifer forest area showing MSF displayed 51-80% overstory canopy remaining in the oldest cohorts.
- Considering the area affected by LSF and MSF (with the majority of trees remaining), 62% was affected by surface fire dominated regimes; the balance (38%) was affected by stand replacement fire dominated regimes. Hence, pre-management era fires of dry forests were strongly surface fire dominated but coming from both low and mixed severity fires.

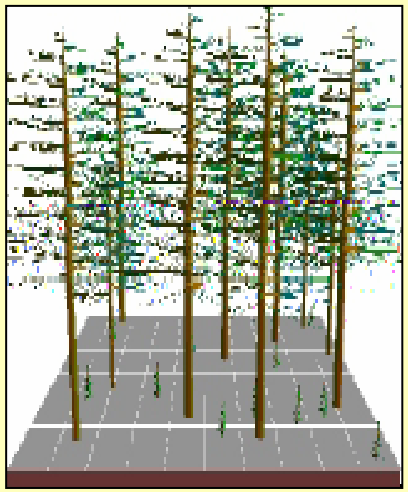
The percentage of the total area of the dry forest that was last affected by MSF



12 Discussion

Pre-management era fire severity and forest structure

- We hypothesized where stable equilibria were operating, patches would be dominated by persistent, structures featuring old, fire-tolerant park-like stands.
- Instead, area was dominated by intermediate-aged forest structures.
- This suggested that before the advent of management, the influence of fire in the dry mixed conifer forest intermittently regenerated rather than maintained large areas of old, fire tolerant forest.
- In the dry mixed conifer forests, LSFs dominated in open stem exclusion structures, which could be maintained by high frequency LSFs and move directly into old single story forest; or perhaps these were the park-like stands described in early fire history studies.



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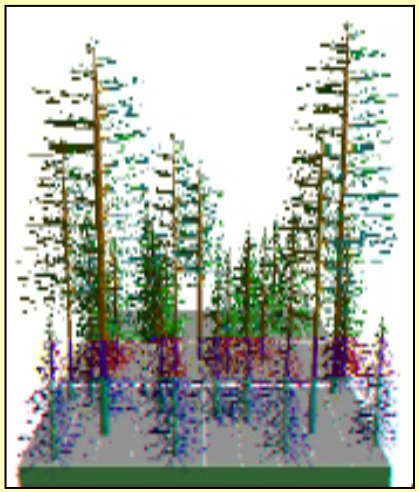

13 Discussion

14 Discussion

15 Discussion

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Thank you for your kind attention